Chapter 21A

Masonry

Comparison Summary

The masonry design chapters of both model codes reference the 2002 edition of the masonry standard, ACI 530-02/ASCE 5-02/TMS 402-02, which we will refer to as *ACI 530-02*. Potential coordination and safety issues will arise from the fact that the primary structural reference, *ASCE 7-02*, refers to the 1999 edition of the masonry standard, *ACI 530-99*. There are significant differences in both the content and organization between the two editions masonry standard, which impact seismic design procedures.

At the national level, *ACI 530-02* is currently being considered for adoption into the 2003 edition of the *NEHRP Provisions*, with subsequent adoption into the 2005 edition of *ASCE 7* (*ASCE 7-05)*. The Building Seismic Safety Council (BSSC), author of the NEHRP Provisions, is considering a total of 11 proposals relating to seismic design of masonry, many of which substantially modify *ACI 530-02*.

IBC 2003

Masonry design provisions are covered in the 29 pages of *IBC* Chapter 21. The chapter contains provisions for both analytical and empirical design. *IBC* Chapter 21 also covers the structural design and anchorage of masonry chimneys in considerable depth.

Few if any conflicts arise from the adoption of both *ASCE 7-02* and *ACI 530-02* in the *IBC*, because *IBC* does not adopt *ASCE 7-02*, Section A9.11, (the section that references *ACI 530-99*). Instead, *IBC* Chapter 21 contains a complete set of seismic design regulations for masonry. These regulations make reference to and are coordinated with the appropriate sections of *ACI 530-02*, and appear to embrace a number of the issues covered in the proposed amendments to *ACI 530-02* being considered for the *2003 NEHRP* provisions.

NFPA 5000

NFPA 5000, Chapter 43 covers masonry design in a little over one-half page, Chapter 43 basically references *ACI 530-02*, without amendment, for nearly all aspects of masonry design. The referenced publication for masonry chimneys, *NFPA 211*, does not appear to cover structural design or anchorage provisions.

Due to the organizational changes made to *ACI 530-02*, the many references in *ASCE 7-02*, Section A9.11, “Supplementary Provisions for Masonry” no longer correspond to the correct references in the masonry standard. In *NFPA 5000*, no discernable effort has been made to coordinate these references. As a result, of the 11 specific section references in *ASCE 7-02* to sections in the masonry standard, 4 are correct, 2 refer to incorrect sections in *ACI 530-02*, and 5 refer to sections that do not exist. It should be noted that since Section 43.2 of *NFPA 5000* refers specifically to *ACI 530-02*, it would be a violation of Section 1.3.2 of *NFPA 5000* code to substitute *ACI 530-99*, the edition referenced in *ASCE 7-02*, for *ACI 530-02*.

Aside from the coordination issues, technical issues surround NFPA's adoption of *ACI 530-02* without amendment. The level of safety provided by *ACI 530-02* as adopted by *NFPA 5000*, without the inclusion of the proposed modifications, is unacceptable.

Summary

No significant conflicts arise from the adoption of both *ASCE 7-02* and *ACI 530-02* in the *IBC*, since *IBC* does not adopt *ASCE 7-02*, Section A9.11, (the section that references *ACI 530-99*). Instead, *IBC* Chapter 21 contains a complete set of seismic design regulations for masonry. *IBC* is coordinated with the appropriate sections of *ACI 530-02*, and appears to embrace a number of the issues covered in the proposed amendments to *ACI 530-02* being considered for the 2003 *NEHRP Provisions*.

In contrast, *NFPA 5000* adopts *ACI 530-02* without amendment, thereby creating significant conflicts. In order to apply *NFPA 5000* to masonry design, users must possess both the 1999 and 2002 masonry standards, and coordinate the section references for themselves. Even then, important safety-related changes to the 2002 masonry standard will only be apparent if the user refers to the 2003 *NEHRP Provisions* or the 2005 edition of *ASCE 7* (*ASCE 7-05*), neither of which are available at this time.

Chapter 21A - Masonry

2001 CBC – Chapter 21A	IBC – Chapter 21	Comments
2101A – General	**2101 - General**	Similar
A.1 Scope	1.1. Scope	Similar
A.2 Design Methods	1.2. Design methods	Similar
A2.1 Working stress design	1.2.1. Working stress design	Similar
-	1.2.3. Prestressed masonry	No provisions for prestressed masonry in CBC.
-	1.2.6. Masonry veneer	CBC requirements for Veneer are in Section 1403A.
-	1.3. Construction documents	Provisions in Part 1 of CBC
-	1.3.1. Fireplace drawings	Fireplace provisions are in Chapter 31of CBC
A.2.2 Strength design	1.2.2. Strength design	Similar
A.2.3 Empirical design	1.2.4. Empirical design	Similar
A.2.4 Glass masonry	1.2.5. Glass masonry	Similar
A.3 Definitions A.4 Notations	**2102 - Definitions and Notations**	Similar
2102A - Material Standards	**2103 - Masonry Construction Materials**	Similar
A.1 Quality A.2 Standards of Quality	2.1. Concrete masonry units	Similar
	2.2. Clay or shale masonry units	Similar
	2.3. Stone masonry units	Similar
	2.4. Ceramic tile	Similar
	2.5. Glass unit masonry	Similar
	2.6. Second-hand units	Similar
2103A - Mortar and Grout A.3 Mortar A.3.1 General A.3.2 Selecting proportions	2.7. Mortar **Table 2103.7 (2)** Mortar Properties	Similar
-	2.8. Surface-bonding mortar	Minimal Impact
-	2.9. Mortars for ceramic wall and floor tile **Table 2103.9** Ceramic Tile Mortar Compositions	Minimal Impact
A.4 Grout.	2.10. Grout	Similar
A.2 Materials Standards Item 7 and 10	2.11. Metal reinforcement … 2.11.1 Deformed reinforcing bars 2.11.2 Joint reinforcement 2.11.3 Deformed reinforcing wire 2.11.4 Wire fabric 2.11.5 Anchors, ties and acces. 2.11.6 Prestressing tendons	Similar

2001 CBC – Chapter 21A	IBC – Chapter 21	Comments
	2.11.7 Corrosion protection 2.11.8 Tests	
A.5 Additives and Admixtures. A.5.1 General A.5.2 Antifreeze compounds A.5.3 Air entrainment A.5.4 Colors	ACI 530.1 Section 2.1, 2.2 through reference to ASTM's for mortar and grout. ACI 530.1 Section 2.6 item 2 and 3.	Minimal Impact
2104A - Construction	**2104 - Construction**	
A.1 General	4.1. Masonry construction – Requires masonry construction to be in accordance with the code and ACI 530.1.	Minimal impact
A.2 Materials: Handling, Storage and Preparation	ACI 530.1 Section 1.7.	Minimal impact
A.3 Cold-weather Construction.	4.3. Cold-weather construction	Minimal Impact
A.4 Placing Masonry Units.	4.1.2 Placing mortar and units	Similar
A.4.1 Mortar	4.1.2.1 Bed and head joints	Similar
A.4.2 Surfaces	-	Minimal Impact
A.4.3 Solid masonry units	4.1.2.3 Solid units	Similar
A.4.4 Hollow-masonry units	4.1.2.2 Hollow units	Similar
2307A - Wood Supporting Masonry or Concrete	4.1.6 Support on wood	Minimal Impact
A.4.5 Corbeling	4.2. Corbelled masonry 4.2.1 Molded cornices	Minimal Impact
-	4.4. Hot weather construction 4.5. Wetting of brick	No requirements found in CBC.
A.5 Reinforcement Placing	ACI 530.1 Section 3.4. – Reinforcement, tie and anchor installation.	Minimal impact
A.6 Grouted Masonry A.6.1 General conditions	ACI 530.1 Section 3.2. – Preparation.	Minimal impact
A.6.1.1 Reinforced grouted masonry	ACI 530.1 Section 3.5. – Grout placement.	5 ft maximum lifts in ACI. Requires further evaluation
A.6.1.1.1 General		
A.6.1.1.2 Low-lift grouted construction		
A.6.1.1.3 High-lift grouted construction		
A.6.1.2 Reinforced hollow-unit masonry.		
A.6.1.2.1 General		

2001 CBC – Chapter 21A	IBC – Chapter 21	Comments
A.6.1.2.2 Low-lift grouted construction *A.6.1.2.3 High-lift grouted construction*		
A.6.1.2.4 Stresses	ACI 530.1 Section 3.5 C. – Grout pour height per Table 7.	Requires further evaluation
A.6.2 Construction requirements	ACI 530.1 Section 3.4. (reinforcement, tie, and anchor installation) and 3.5 (grout placement).	Requires further evaluation
A.7 Aluminum Equipment	-	Minimal impact
A.8 Joint Reinforcement	ACI 530, Section 1.12.4.2 – Reinforcement Protection. ACI 530, Section 7.7 ACI 530.1, Section 2.4 C and E.	ACI Requirements are not consistent with CBC requirements.
2105A – Quality Assurance	**2105 – Quality Assurance**	Similar
A.1 General A.2 Scope	5.1. General – Quality assurance program. Reference to Chapt. 17.	Minimal impact
A.3 Compliance with *f'm* *A.3.0 f'm*	5.2. Acceptance relative to strength requirements 5.2.1 Compliance with f'm	Minimal impact
A.3.1 *Masonry core testing*		Amendment language in CBC. No equivalent language found in IBC.
A.3.2 Masonry prism testing A.3.3 Masonry prism test record	5.2.2.2 Prism test method. 5.2.2.2.1 General 5.2.2.2.2 Number of prisms per test	Minimal impact
A.3.4 Unit strength method	5.2.2 Determination of compressive strength 5.2.2.1 Unit strength method 5.2.2.1.1 Clay masonry 5.2.2.1.2 Concrete masonry	Minimal impact
A.3.5 Testing prisms from constructed masonry Paragraph 1 Paragraph 2 Paragraph 3	5.3. Testing prisms from constructed masonry 5.3.1 Prism sampling and removal 5.3.2 Compressive strength calcs. 5.3.3 Compliance	Minimal impact
A.6 Combination of Units		Amendment language in CBC. No equivalent language found in IBC.
A.7 Masonry Inspection		Amendment language in CBC. No equivalent language found in IBC. IBC Chapter 17 requires continuous inspection for grouting, welding reinf. … but not laying masonry units.

Chapter 21A - Masonry

2001 CBC – Chapter 21A	IBC – Chapter 21	Comments
2106A - General Design Requirements A.1 General	ACI 530 Chapter 1 – General Design requirements for masonry	IBC Design Sections 2106 (Seismic), 2107 (Working Stress), 2108 (Strength), and 2109 (Empirical), reference ACI 530.
A.1.1 Scope	ACI 530 Section 1.1 - Scope	Minimal impact
A.1.2 Plans	ACI 530 Section 1.2 – Contract Documents	Minimal impact
A.1.3 Design loads.	ACI 530 Section 1.7 - Loading	Minimal impact
A.1.4 Stack bond	ACI 530 Section 1.11 – Stack Bond	Minimal impact
A.1.5 Multiwythe walls.	ACI 530 Section 2.1.5 – Multiwythe walls	Minimal impact
A.1.6 Vertical support – Not allowed to be supported by wood.	2104.1.5 Lintels 2104.1.6 Support on wood	Minimal impact
A.1.7 Lateral support	-	Minimal impact
A.1.8 Protection of ties and joint reinforcement	ACI 530 Section 1.2.4 – Protection of Reinforcement	Minimal impact
A.1.9 Pipes and conduits embedded in masonry	ACI 530 Section 1.15.2 – Embedded conduits, pipes, and sleeves.	Minimal impact
A.1.10 Load tests	-	Minimal impact
A.1.11 Reuse of masonry units	-	Minimal impact
A.1.12 Special provisions in areas of seismic risk. A.1.12.1 General A.1.12.4 Special provisions for Seismic Zones 3 and 4	**2106 Seismic Design** 6.1. Seismic design requirements for masonry 6.1.1 Basic seismic-force-resisting system 6.1.1.1 Ordinary plain prestressed masonry shear walls 6.1.1.2 Intermediate prestressed masonry shear walls 6.1.1.3 Special prestressed masonry shear walls 6.2. Anchorage of masonry walls 6.3. Seismic Design Category B 6.3.1 Masonry walls not part of the lateral force resisting system 6.4. Additional requirements for structures in Seismic Design Category C 6.4.1 Design of Discontinuous members that are not part of the lateral-force-resisting system. 6.5. Additional requirements for structures in Seismic Design Category D	There are no prestressed masonry provisions in CBC. There are no prestressed masonry provisions in CBC. There are no prestressed masonry provisions in CBC.

2001 CBC – Chapter 21A	IBC – Chapter 21	Comments
	6.6. Additional requirements for structures in Seismic Design Category E or F	
A.2 Working Stress Design and Strength Design Requirements for Unreinforced and Reinforced Masonry. A.2.1 General	-	
A.2.3.3 *Walls and Piers. Thickness ofWalls*	ACI 530 Section 1.6 – Definitions Pier	CBC Dimensional limits are different from ACI limits.
A.2.4 Effective height	ACI 530 Section 1.6 – Definitions Effective height	Minimal impact
A.2.5 Effective area	ACI 530 Section 1.6 – Definitions Area, net cross-sectional	Minimal impact
A.2.6 Effective width of intersecting walls	ACI 530 Section 1.9.4 – Intersecting Walls	Minimal impact
A.2.7 Distribution of concentrated vertical loads in walls	ACI 530 Section 2.1.9 – Concentrated loads	ACI requirement is in Allowable Stress Design chapter. Unable to find similar requirement in Strength Design chapter.
A.2.14 Placement of embedded anchor bolts	ACI 530 Section 2.1.4 – Anchor Bolts Solidly Grouted in Masonry. ACI 530 Section 3.1.6 – Headed and bent-bar anchor bolts.	ACI includes plate anchors, headed anchor bolts and J or L anchor bolts. CBC requires Hex Head anchor bolts.
A.3 Working Stress Design and Strength Design Requirements for Reinforced Masonry A.3.1 General	-	Similar provisions noted below
A.3.2 Plain bars	-	No effect
A.3.3 Spacing of longitudinal reinforcement	ACI 530 Section 1.12.3 – Placement of reinforcement	Minimal impact
A.3.4 Anchorage of flexural reinforcement	ACI 530 Section 2.1.10.3 – Embed. Of flexural reinforcement	This requirement was only found in the working stress design chapter of ACI. Appears to be general requirement that applies to both working stress and strength design.
A.3.5 Anchorage of shear reinforcement	ACI 530 Section 2.1.10.5 and ACI 530 Section 3.2.3.3.1 Development of shear reinforcement.	Minimal impact
A.3.6 Lateral ties	ACI 530 Section 2.1.6.5 and ACI 530 Section 3.2.4.4.2 – Lateral Ties	Minimal impact
A.3.7 Column anchor bolt ties	-	Requirement not found in IBC/ACI
A.3.8 Effective width *b* of compression area	ACI 530 Section 2.3.3.3 – Effective compressive width per bar.	This requirement was only found in the working stress design chapter of ACI. Appears to be general requirement that applies to both working stress and

2001 CBC – Chapter 21A	IBC – Chapter 21	Comments
		strength design.
2107A Working Stress Design of Masonry A.1 General. A.1.1 Scope	**2107 Working Stress Design** 7.1. General 7.2. Modifications to ACI 530/ASCE 5/TMS 402. 7.2.1 ACI 530/ASCE 5/TMS 402, Chapter 2 7.2.2 ACI 530/ASCE 5/TMS 402, 2.1.6 7.2.3 ACI 530/ASCE 5/TMS 420, 7.2.1.10.6.1.1, lap splices 7.2.4 ACI 530/ASCE 5/TMS 402, maximum bar size 7.2.5 ACI 530/ASCE 5/TMS 402, splice for large bars.	Requires further evaluation
A.1.3 Minimum dimensions for masonry structures located in Seismic Zones 3 and 4.	-	Requirement not found in IBC/ACI, evaluate for continuation as amendment to IBC
A.1.5 Embedded anchor bolts	ACI 530 Section 2.1.4 – Anchor Bolts …	Minimal impact
A.1.6 Compression in walls and columns	ACI 530 Section 2.1.9 – Concentrated loads	Minimal impact
A.1.7 Shear walls, design loads	2106.5.1 – Loads for Shearwalls Designed by the Working Stress Method	Load increase is only require for Seismic Design Category C and greater.
A.1.8 Design, composite construction	ACI 530 Section 2.1.5.2 – Composite action	Detailed comparison of the two sections should be performed to evaluate the need for amendment(s).
A.1.9 Reuse of masonry units	2103.6 Second hand units	CBC requires using 50 percent of the allowable stress for new units. No reduction in IBC.
A.2 Design of Reinforced Masonry	ACI 530 Section 2.3 - Reinforced Masonry	Similar
A.2.1 Scope – requirements for masonry with reinforcement.	ACI 530 Section 2.3.1 Scope – requirements for allowable stress design …	Scope of two codes is similar however a detailed comparison of the two codes should be performed to evaluate the need to amend IBC/ACI 530.
2108A - Strength Design of Masonry	**2108 Strength Design of Masonry** 8.2. ACI 530/ASCE 5/TMS 402, Section 3.2.2(g) 8.3. ACI 530/ASCE 5/TMS 402, Section 3.2.3.4 8.4. ACI 530/ASCE 5/TMS 402, Section 3.2.3.5.1	Requires further evaluation
A.1 General A.1.1 General provisions	8.1. General ACI 530 Section 3.1 – General ACI 530 Section 3.1.1 - Scope	ACI includes unreinforced masonry which is not allowed by CBC
A.2 Reinforced Masonry	ACI 530 Section 3.2 - Reinforced	Similar

2001 CBC – Chapter 21A	IBC – Chapter 21	Comments
	Masonry	
A.2.1 General	ACI 530 Section 3.2.1 – Scope Masonry design with reinforcement.	Scope of two codes is similar however a detailed comparison of the two codes should be performed to evaluate the need to amend IBC/ACI 530.
A.2.3 Design of beams, piers and columns	ACI 530 Section 3.2.4.3 - Piers	
A.2.4 Wall design for out-of-plane loads	ACI 530 Section 3.2.5 – Wall design for out-of-plane loads	
A.2.5 Wall design for in-plane loads	ACI 530 Section 3.2.6 – Wall design for in-plane loads	
A.2.6 Design of moment-resisting wall frames	-	No provisions for moment resisting wall frames found in ACI.
-	ACI Section 3.3 - Unreinforced (Plain) Masonry	Unreinforced masonry is not allowed under CBC. Evaluate for non-adoption by OSHPD
-	ACI 530 Chapter 4 - Prestressed Masonry	No provisions for prestressed masonry in CBC. Evaluate for adoption (or non-adoption)
2109A Empirical Design of Masonry A.1 General CBC limits use of empirically designed masonry to: 1) Buildings in Seismic Zones 0 and 1 *(this renders 2109A inapplicable to OSHPD projects)* 2) Buildings designed for a wind speed less than 80 mph. 3) Buildings less than 35 feet in height. A.2 Height A.3 Lateral Stability A.4 Compressive Stresses A.5 Lateral Support A.6 Minimum Thickness A.7 Bond A.8 Anchorage A.9 Unburned Clay Masonry	**2109 - Empirical Design of Masonry** 9.1 General 9.1.1 Limitations 1) Elements not part of the seismic load resisting system of buildings in Seismic Design Categories A and B. 2) Masonry structures in areas with 110 mph wind speed (3-second gust). 3) Buildings greater than 35 feet in height. 9.2 Lateral Stability 9.3 Compressive Stresses 9.4 Lateral support. **Table 2109.4.1** Wall Lateral Support Requirements 9.5 Thickness of masonry. 9.6 Bond 9.7 Anchorage. 9.8 Adobe construction	Under the IBC, OSHPD could see buildings falling in Seismic Design Category B that would allow empirical design masonry to be used for non-structural partition walls.
A.10 Stone Masonry	9.5.3 Rubble Stone Walls 9.6.4 Bonding with natural or cast stone.	
Table 16A-V Maximum Diaphragm Dimension Ratios	**Table 2109.2.1.3** Diaphragms Length-to-Width Ratios	Minimal impact

2001 CBC – Chapter 21A	IBC – Chapter 21	Comments
No provisions found for dry stacked walls	**Table 2109.2.3.1** Allowable Stress Gross Cross-Sectional Area for Dry-Stacked, Surface-Bonded Concrete Masonry Walls	Requires further evaluation
Table 21A-M Allowable Compressive Stresses for Empirical Design of Masonry (not adopted by OSHPD)	**Table 2109.3.2** Allowable Compressive Stresses for Empirical Design of Masonry	Referenced table in CBC column is a UBC table not adopted by OSHPD.
Table 21A-P Thickness of Foundation Walls for Empirical Design of Masonry (not adopted by OSHPD)	**Table 2109.5.6.1** Foundation Wall Construction	Referenced table in CBC column is a UBC table not adopted by OSHPD
Table 21A-Q Allowable Shear on Bolts for Masonry of Unburned Clay (not adopted by OSHPD)	**Table 2109.8.3.1** Allowable Shear on Bolts in Adobe Masonry	Referenced table in CBC column is a UBC table not adopted by OSHPD.
2110A - GLASS MASONRY A.1 General A.2 Mortar Joints (2110A.1 refers to Sec. 2113A for requirements)	**2110 - Glass Unit Masonry** 10.1 Scope 10.2 Units. Hollow or solid glass block units shall be standard or thin units. 10.3 Panel size. Figure 2110.3.1 Glass Masonry Design Wind Load Resistance 10.4 Support. 10.5 Expansion joints 10.6 Mortar 10.7 Reinforcement 2104.1.2.4 Glass unit masonry	Requires further evaluation
2111A - Chimneys, Fireplaces and Barbecues (CBC Refers to Chapter 31 of the CBC for design and construction requirements)	**2111 - Masonry Fireplaces** **2113 Masonry Chimneys**	See comparison of CBC Chapter 31
2112A NONBEARING WALLS (entire section is OSHPD amendment)	ACI 530 Section 1.13.5.2.2 Masonry Partition Walls, Screen Walls	The IBC does not have a specific reference to ACI 530 for partitions and screen walls, but references ACI 530 under specific masonry design methods. CBC amendment language has more specific/detailed requirements.
2113A - MASONRY SCREEN WALLS (entire section is OSHPD amendment)	ACI 530 Section 1.13.5.2.2 Masonry Partition Walls, Screen Walls	The IBC does not have a specific reference to ACI 530 for partitions and screen walls, but references ACI 530 under specific masonry design methods. CBC amendment language has more specific requirements.

2001 CBC – Chapter 21A	IBC – Chapter 21	Comments
2114A - USE OF EXISTING MASONRY (entire section is OSHPD amendment) *A.1 General* – limits use. Existing masonry must meet reinforced grouted masonry requirements to be used for structural purpose.	-	No provisions found in IBC chapter 21.
2115A TESTS AND INSPECTIONS (entire section is OSHPD amendment) *A.1 See Section 2105A*	IBC Chapter 17.	See comparison of CBC Chapter 17A.
Table 21A-A Mortar Proportions for Unit Masonry	**Table 2103.7 (1)** Mortar Proportions	Similar
Table 21A-B Grout Proportions by Volume	**Table 2103.10** Grout Proportions by Volume for Masonry Construction	Similar
Table 21A-C Grouting Limitations	ACI 530.1 – Table 7	The tables differ and should be compared to determine if amendment is required.
Table 21A-D Specified Compressive Strength of Masonry, *f'm* (psi) Based on Specifying the Compressive Strength of Masonry	**Table 2105.2.2.1.1** Compressive Strength of Clay Masonry **Table 2105.2.2.1.2** Compressive Strength of Concrete Masonry	Minimal impact
Table 21A-E-1 Allowable Tension, *Bt* , for Embedded Anchor Bolts for Clay and Concrete Masonry	-	No Table found in IBC/ACI 530
Table 21A-E-2 Allowable Tension, *Bt* , for Embedded Anchor Bolts for Clay and Concrete Masonry	-	No Table found in IBC/ACI 530
Table 21A-F Allowable Shear, *Bv*, for Embedded Anchor Bolts for Clay and Concrete Masonry	-	No Table found in IBC/ACI 530
Table 21A-G Minimum Diameters of Bend	ACI 530 Table 1.12.6.1	ACI Table includes bend diameter for #3 -#7 bars of grade 40 steel.
Table 21A-H-1 Radius of Gyration for Concrete Masonry Units	-	No Table found in IBC/ACI 530
Table 21A-H-2	-	No Table found in IBC/ACI 530

2001 CBC – Chapter 21A	IBC – Chapter 21	Comments
Radius of Gyration for Clay Masonry Unit Length, 16 Inches		
Table 21A-H-3 Radius of Gyration for Clay Masonry Unit Length, 12 Inches	-	No Table found in IBC/ACI 530
Table 21A-I Allowable Flexural Tension (psi)	ACI 530 Table 2.2.3.2	The tables differ and should be compared to determine if amendment is required.
Table 21A-J Maximum Nominal Shear Strength Values	ACI 530 Section 3.2.4.1 – Nominal strength. Formulas (3-19) & (3-20)	CBC limits the nominal shear strength, ACI 530 does not appear to have limits. Verify if A_e used in CBC is equivalent to A_n used in ACI.
Table 21A-K Nominal Shear Strength Coefficient	ACI 530 Section 3.2.4.1 – Nominal strength. Formula (3-21).	This section will require further evaluation to determine if there is a difference between the CBC and ACI 530. CBC limits the nominal shear strength, ACI 530 does not appear to have limits.
Table 21A-R *Minimum Thickness of Masonry*	ACI 530 Section 5.6 – Thickness of masonry	Cited ACI 530 section is specific to Empirical design of masonry. CBC minimum thickness requirements are general and cited in various CBC sections.

Chapter 21A - Masonry

2001 CBC - Chapter 21A	NFPA 5000 – Chapter 43	Comments
2101A - General	**43.2 General**	-
A.1 Scope – Material, Design, construction and quality assurance of masonry.	43.1 Scope – Design and const. Of masonry. 43.2 General – Reference to ACI 530/ASCE 5/TMS 402.	NFPA 5000 references ACI 530-02 for masonry design and construction provisions, with a few additional requirements contained in NFPA 5000, including 43.6 and 43.7.
A.2 Design Methods A.2.1 Working stress design A.2.2 Strength design - A.2.3 Empirical design - A.2.4 Glass masonry	43.3 Design (1) Working stress design (2) Strength design (3) Prestressed Masonry (4) Empirical design (5) Veneer (6) Glass masonry	Evaluate pre-stress design provisions
-	43.4 Construction documents	Minimal impact
-	43.7 Masonry Construction – Reference to ACI 530.1/ASCE 6/TMS 602.	NFPA 5000 specifies that masonry construction is to comply with ACI 530-02 provisions and additional provisions contained in NFPA 5000 43.7.1 through 43.7.4 (open-end unit requirements). This conflicts with the reference to ASCE 7-02 Section 9.11 to ACI 530-99.
A.3 Definitions	ACI Section 1.6 - Definitions	Provisions contained in referenced standard
A.4 Notations	ACI Section 1.5 - Notations	Provisions contained in referenced standard
2102A - Material Standards A.1 Quality A.2 Standards of Quality	43.6 Masonry Construction Materials References ACI 530, 530.1	Provisions contained in referenced standard
2103A - Mortar and Grout A.1 General A.2 Materials A.3 Mortar A.3.1 General A.3.2 Selecting proportions	43.6 Masonry Construction Materials ACI 530.1 Section 2.1 – Mortar materials. Requirements by reference to ASTM C 270	Provisions contained in referenced standard ASTM C 270-99b (Approx. 4 pages)
A.4 Grout A.4.1 General A.4.2 Selecting proportions *A.4.3 Aggregate*	ACI 530.1 Section 2.2 – Grout materials. Requirements by reference to ASTM C 476	ASTM C 476-99 (2 pages)
A.5 Additives and Admixtures. A.5.1 General A.5.2 Antifreeze compounds A.5.3 Air entrainment A.5.4 Colors	ACI 530.1 Section 2.1, 2.2 through reference to ASTM's for mortar and grout. ACI 530.1 Section 2.6 item 2 and 3.	Minimal impact
2104A - Construction	43.7 Masonry Construction References 43.7.1 through 43.7.4,	Provisions mostly contained in referenced Standard ACI 530.1, which is a model specification

2001 CBC - Chapter 21A	NFPA 5000 – Chapter 43	Comments
	and ACI 530.1 provisions	
A.1 General	43.7	Provisions contained in referenced standard
A.2 Materials: Handling, Storage and Preparation	ACI 530.1 Section 1.7.	Provisions contained in referenced standard
A.3 Cold-weather Construction.	ACI 530.1 Section 1.8 C. – Cold weather construction.	Provisions contained in referenced standard
-	ACI 530.1 Section 1.8 D. – Hot weather construction	No requirements found in CBC.
A.4 Placing Masonry Units.	ACI 530.1 Section 3.3. – Masonry Erection.	Provisions contained in referenced standard
A.4.1 Mortar		
A.4.2 Surfaces		
A.4.3 Solid masonry units		
A.4.4 Hollow-masonry units		
A.4.5 Corbeling		
A.5 Reinforcement Placing	ACI 530.1 Section 3.4. – Reinforcement, tie and anchor installation.	Provisions contained in referenced standard
A.6 Grouted Masonry. A.6.1 General conditions	ACI 530.1 Section 3.2. – Preparation.	Provisions contained in referenced standard
A.6.1.1 Reinforced grouted masonry.	ACI 530.1 Section 3.5. – Grout placement.	Provisions contained in referenced standard 5 ft maximum lifts in ACI. Requires further evaluation
A.6.1.1.1 General		
A.6.1.1.2 Low-lift grouted construction		
A.6.1.1.3 High-lift grouted construction		
A.6.1.2 Reinforced hollow-unit masonry.		
A.6.1.2.1 General		
A.6.1.2.2 Low-lift grouted construction		
A.6.1.2.3 High-lift grouted construction		
A.6.1.2.4 Stresses	ACI 530.1 Section 3.5 C. – Grout pour height per Table 7.	Requires further evaluation
A.6.2 Construction requirements	ACI 530.1 Section 3.4. (reinforcement, tie, and anchor installation) and 3.5 (grout placement).	Requires further evaluation
A.7 Aluminum Equipment	-	Continue CBC provision
A.8 Joint Reinforcement	ACI 530, Section 1.12.4.2 – Reinforcement Protection.	Provisions contained in referenced standard ACI Requirements are not consistent with CBC

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	ACI 530, Section 7.7 ACI 530.1, Section 2.4 C and E.	requirements.
2105A - Quality Assurance	43.5 Quality Assurance	Sec. 43.5 references Sec. 40.3.9, which makes general reference to ACI 530. Review of ACI 530 Sec. 1.14 indicates several issues to be addressed via amendment, including: - define Level 1, 2, or 3 QA - define criteria for lab/inspector approval - QA program requirements not defined, will need amendments to clarify also – 40.1.6.1 contractor quality control program Also – ACI 530 references ACI 530.1, which contains a model specification for design professionals to incorporate into project documents, and contains more specific requirements for materials than ACI 530 Sec. 1.14
A.1 General		
A.2 Scope		
A.3 Compliance with *f'm*		
A.3.0 f'm		
A.3.1 *Masonry core testing*		
A.3.2 Masonry prism testing		
A.3.3 Masonry prism test record		
A.3.4 Unit strength method		
A.3.5 Testing prisms from constructed masonry		
A.6 Combination of Units		
A.7 Masonry Inspection		
2106A - General Design Requirements	ACI 530 Ch. 1 – General Design Requirements for Masonry	Provisions contained in referenced standard ACI 530
A.1 General.	-	No effect
A.1.1 Scope	ACI 530 Section 1.1 - Scope	Minimal impact
A.1.2 Plans	ACI 530 Section 1.2 – Contract Documents	Minimal impact
A.1.3 Design loads.	ACI 530 Section 1.7 - Loading	Minimal impact
A.1.4 Stack bond	ACI 530 Section 1.11 – Stack Bond	Minimal impact
A.1.5 Multiwythe walls.	ACI 530 Section 2.1.5 – Multiwythe walls	Minimal impact
A.1.6 Vertical support	-	Minimal impact
A.1.7 Lateral support	-	Minimal impact
A.1.8 Protection of ties and joint reinforcement	ACI 530 Section 1.2.4 – Protection of Reinforcement	Minimal impact
A.1.9 Pipes and conduits embedded in masonry	ACI 530 Section 1.15.2 – Embedded conduits, pipes, and sleeves.	Minimal impact
A.1.10 Load tests	-	Minimal impact
A.1.11 Reuse of masonry units	43.6.1 Second-Hand Units	Minimal impact

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A.1.12 Special provisions in areas of seismic risk. A.1.12.1 General A.1.12.4 Special provisions for Seismic Zones 3 and 4	43.8 Seismic requirements 43.8.1 General – Reference to Section 1.13 of ACI 530/ASCE 5/TMS 402. 43.8.2 One- and Two-Family Dwellings	Requires further evaluation
A.2 Working Stress Design and Strength Design Requirements for Unreinforced and Reinforced Masonry. A.2.1 General	-	
A.2.3.3 *Walls and Piers. Thickness of Walls per Table 21A-R.*	ACI 530 Section 1.6 – Definitions Pier	CBC Dimensional limits are different from ACI limits.
A.2.4 Effective height	ACI 530 Section 1.6 – Definitions Effective height	Minimal impact
A.2.5 Effective area	ACI 530 Section 1.6 – Definitions Area, net cross-sectional	Minimal impact
A.2.6 Effective width of intersecting walls	ACI 530 Section 1.9.4 – Intersecting Walls	Minimal impact
A.2.7 Distribution of concentrated vertical loads in walls	ACI 530 Section 2.1.9 – Concentrated loads	ACI requirement is in Allowable Stress Design chapter. Unable to find similar requirement in Strength Design chapter.
A.2.14 Placement of embedded anchor bolts	ACI 530 Section 2.1.4 – Anchor Bolts Solidly Grouted in Masonry. ACI 530 Section 3.1.6 – Headed and bent-bar anchor bolts.	ACI includes plate anchors, headed anchor bolts and J or L anchor bolts. CBC requires Hex Head anchor bolts.
A.3 Working Stress Design and Strength Design Requirements for Reinforced Masonry A.3.1 General	-	-
A.3.2 Plain bars	-	Minimal impact
A.3.3 Spacing of longitudinal reinforcement	ACI 530 Section 1.12.3 – Placement of reinforcement	Minimal impact
A.3.4 Anchorage of flexural reinforcement	ACI 530 Section 2.1.10.3 – Embed. of flexural reinforcement	This requirement was only found in the working stress design chapter of ACI. Appears to be general requirement that applies to both working stress and strength design.
A.3.5 Anchorage of shear reinforcement	ACI 530 Section 2.1.10.5 and ACI 530 Section 3.2.3.3.1 Development of shear reinforcement.	Minimal impact
A.3.6 Lateral ties	ACI 530 Section 2.1.6.5 and ACI 530 Section 3.2.4.4.2 – Lateral Ties	Minimal impact

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A.3.7 Column anchor bolt ties	-	Requirement not found in NFPA/ACI
A.3.8 Effective width *b* of compression area	ACI 530 Section 2.3.3.3 – Effective compressive width per bar.	This requirement was only found in the working stress design chapter of ACI. Appears to be general requirement that applies to both working stress and strength design.
2107A - Working Stress Design of Masonry A.1 General. A.1.1 Scope	ACI 530 Chapter 2 – ALLOWABLE STRESS DESIGN OF MASONRY ACI 530 Section 2.1 - General ACI 530 Section 2.1.1 - Scope	Minimal impact
A.1.3 Minimum dimensions for masonry structures located in Seismic Zones 3 and 4.	-	Requirement not found in NFPA/ACI
A.1.5 Embedded anchor bolts	ACI 530 Section 2.1.4 – Anchor Bolts …	Minimal impact
A.1.6 Compression in walls and columns	ACI 530 Section 2.1.9 – Concentrated loads	Minimal impact
A.1.7 Shear walls, design loads	-	Requirement not found in NFPA/ACI
A.1.8 Design, composite construction	ACI 530 Section 2.1.5.2 – Composite action	Comparison of the two sections should be performed to evaluate the need for amendment(s).
A.1.9 Reuse of masonry units	43.6.1 Second hand units	CBC requires using 50 percent of the allowable stress for new units. No reduction in NFPA.
-	ACI 530 Section 2.2 - Unreinforced Masonry	Unreinforced masonry is not allowed under CBC. UBC Section 2107.3 (Design of unreinforced masonry) is not adopted in CBC.
A.2 Design of Reinforced Masonry	ACI 530 Section 2.3 - Reinforced Masonry	-
A.2.1 Scope – requirements for masonry with reinforcement.	ACI 530 Section 2.3.1 Scope – requirements for allowable stress design …	Scope of two codes is similar however a detailed comparison of the two codes should be performed to evaluate the need to amend NFPA/ACI 530.
2108A - Strength Design of Masonry	ACI 530 Chapter 3 – STRENGTH DESIGN OF MASONRY	-
A.1 General A.1.1 General provisions	ACI 530 Section 3.1 – General ACI 530 Section 3.1.1 - Scope	NFPA/ACI includes unreinforced masonry which is not allowed by CBC.
A.2 Reinforced Masonry	ACI 530 Section 3.2 - Reinforced Masonry	-
A.2.1 General	ACI 530 Section 3.2.1 – Scope Masonry design with reinforcement.	Scope of two codes is similar however a detailed comparison of the two codes should be performed to evaluate the need to amend NFPA/ACI 530.
A.2.3 Design of beams, piers and columns	ACI 530 Section 3.2.4.3 - Piers	
A.2.4 Wall design for out-of-plane loads	ACI 530 Section 3.2.5 – Wall design for out-of-plane loads	
A.2.5 Wall design for in-plane loads	ACI 530 Section 3.2.6 – Wall design for in-plane loads	

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A.2.6 Design of moment-resisting wall frames	-	No provisions for moment resisting wall frames found in NFPA/ACI.
-	ACI Section 3.3 - Unreinforced (Plain) Masonry	Unreinforced masonry is not allowed under CBC.
-	ACI 530 CHAPTER 4 - PRESTRESSED MASONRY	No provisions for prestressed masonry in CBC.
2109A - Empirical Design of Masonry	ACI 530 CHAPTER 5 - EMPIRICAL DESIGN OF MASONRY	
A.1 General	ACI 530 Section 5.1 – Scope ACI 530 Section 5.1.2 – Limitations	CBC limits use of empirically designed masonry to Seismic Zones 0 and 1 with wind speed less than 80 mph. NFPA/ACI limits use to Seismic Design Categories A and B and 90 mph wind speed (Fastest Mile). Under NFPA/ASCE 7, OSHPD could see buildings falling in Seismic Design Category B which would allow empirical design masonry to be used.
-	ACI 530 CHAPTER 6 - VENEER	CBC requirements for Veneer are in Section 1403A.
2110A - Glass Masonry	ACI 530 CHAPTER 7 – GLASS MASONRY	
A.1 General	7.1 General 7.1.1 Scope	Scope of two codes is similar however a detailed comparison of the two codes should be performed to evaluate the need to amend NFPA/ACI 530. Maximum panel size limit in CBC (Section 2113A.1 item 4) is more restrictive than ACI 530 (Section 7.2)
2112A - Nonbearing Walls	ACI 530 SECTION 1.13.5.2.2 MASONRY PARTITION WALLS, SCREEN WALLS …	CBC amendment language has more specific/detailed requirements.
2113A - Masonry Screen Walls	ACI 530 SECTION 1.13.5.2.2 MASONRY PARTITION WALLS, SCREEN WALLS …	CBC amendment language has more specific/detailed requirements
2114A - Use of Existing Masonry *A.1 General* – limits use. Existing masonry must meet reinforced grouted masonry requirements to be used for structural purpose.	-	No provisions in NFPA chapter 43. There may be some requirements in NFPA Chapter 15.
2115A – Tests and Inspections *A.1* - references 2105A	Chapter 40 – Quality Assurance During Construction	See comparison of CBC Chapter 17A.
Table 21A-A Mortar Proportions for Unit Masonry	ASTM 270-99b - Table 1	ASTM covers mortar types not found in CBC.
Table 21A-B Grout Proportions by Volume	ASTM 476-99 - Table 1	Tables appear to be consistent.
Table 21A-C Grouting Limitations	ACI 530.1 – Table 7	The tables differ and should be compared to determine if amendment is required.
Table 21A-D	ACI 530.1 – Table 1 and Table 2.	The tables differ and should be compared to determine if

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Specified Compressive Strength of Masonry, *f'm* (psi) Based on Specifying the Compressive Strength of Masonry Units		amendment is required.
Table 21A-E-1 Allowable Tension, *Bt* , for Embedded Anchor Bolts for Clay and Concrete Masonry	-	No Table found in NFPA/ACI
Table 21A-E-2 Allowable Tension, *Bt* , for Embedded Anchor Bolts for Clay and Concrete Masonry	-	No Table found in NFPA/ACI
Table 21A-F Allowable Shear, *Bv*, for Embedded Anchor Bolts for Clay and Concrete Masonry	-	No Table found in NFPA/ACI
Table 21A-G Minimum Diameters of Bend	ACI 530 Table 1.12.6.1	ACI Table includes bend diameter for #3 -#7 bars of grade 40 steel.
Table 21A-H-1 Radius of Gyration for Concrete Masonry Units	-	No Table found in NFPA/ACI
Table 21A-H-2 Radius of Gyration for Clay Masonry Unit Length, 16 Inches	-	No Table found in NFPA/ACI
Table 21A-H-3 Radius of Gyration for Clay Masonry Units Length, 12 Inches	-	No Table found in NFPA/ACI
Table 21A-I Allowable Flexural Tension (psi)	ACI 530 Table 2.2.3.2	The tables differ and should be compared to determine if amendment is required.
Table 21A-J Maximum Nominal Shear Strength Values	ACI 530 Section 3.2.4.1 – Nominal strength. Formulas (3-19) & (3-20)	CBC limits the nominal shear strength, ACI does not appear to have limits. Verify if A_e used in CBC is equivalent to A_n used in ACI.
Table 21A-K Nominal Shear Strength Coefficient - used in section 2108A.2.3.6.2	ACI 530 Section 3.2.4.1 – Nominal strength. Formula (3-21).	This section will require further evaluation to determine if there is a difference between the CBC and ACI. CBC limits the nominal shear strength, ACI does not appear to have limits.
Table 21A-R *Minimum Thickness of Masonry*	ACI 530 Section 5.6 – Thickness of masonry	Cited ACI section is specific to Empirical design of masonry. CBC minimum thickness requirements are general and cited in various CBC sections.